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# PHASE I RFI/RI ENVIRONMENTAL EVALUATION FIELD IMPLEMENTATION PLAN

## ADDENDUM NO.1 ADDITIONAL POND SEDIMENT INVESTIGATIONS

ROCKY FLATS PLANT
WALNUT CREEK PRIORITY DRAINAGE
(Operable Unit No. 6)

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

ENVIRONMENTAL RESTORATION PROGRAM
February 11, 1994

ORD

DOCUMENT CLASSIFICATION REVIEW WAIVER PER CLASSIFICATION OFFICE

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**DRAFT**
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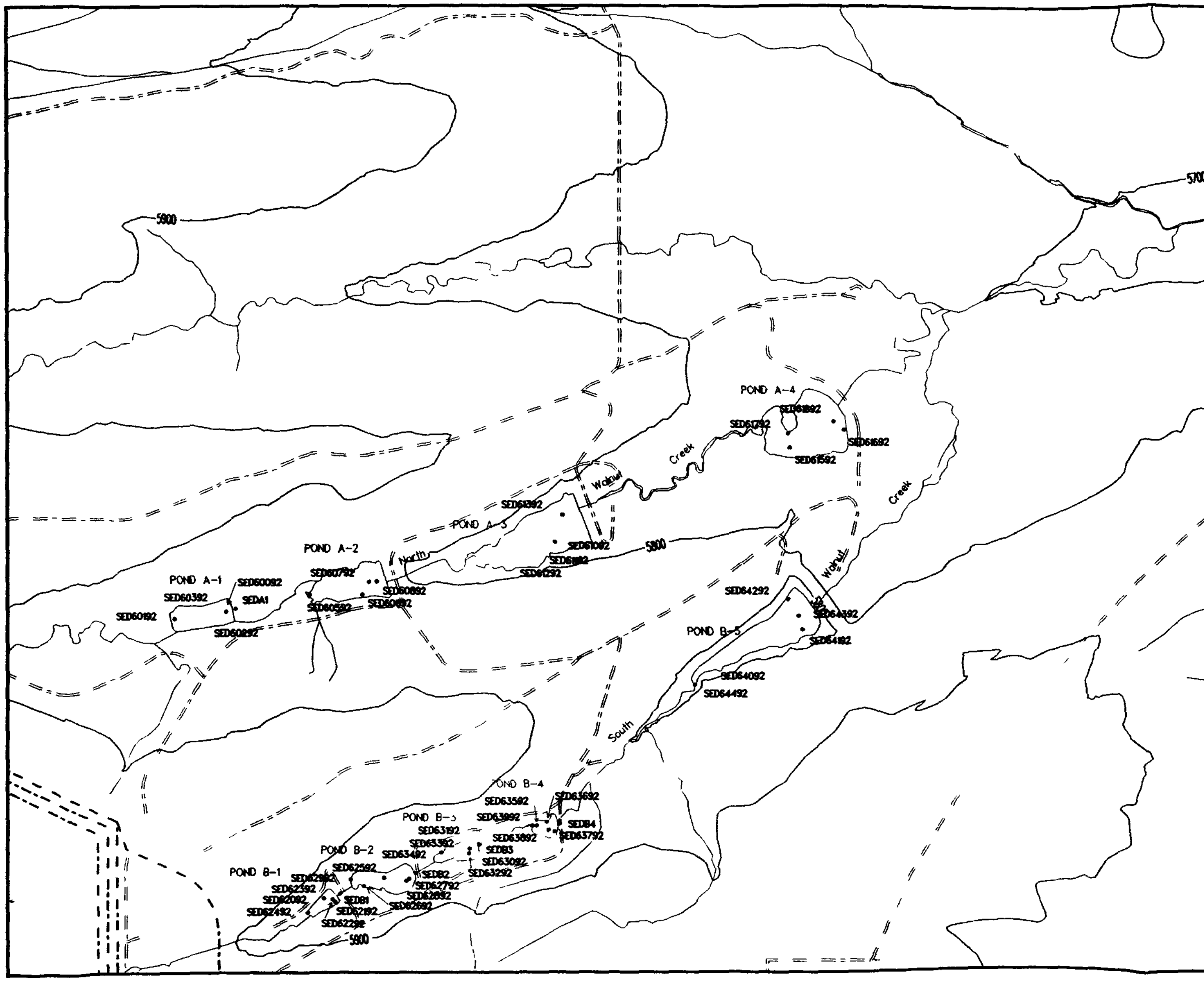
## 1.0 Introduction

Operable Unit (OU) 6—Walnut Creek Priority Drainage of the Rocky Flats Plant (RFP) includes 10 surface-water impoundments, the A- and B-series ponds, constructed on the north and south forks of Walnut Creek (Figure 1) The ponds receive run-off from the industrialized area of RFP and are designated as Individual Hazardous Substance Sites (IHSSs) During the Phase I RCRA Facility Investigation/Remedial Investigation (RFI/RI) of OU6, polychlorinated biphenyls (PCBs) were detected in sediment samples from ponds in both series PCBs are common environmental contaminants released from electrical generators and transformers, where they are used for electrical insulation PCBs are known to be toxic to both human health and the environment

The purpose of this document is to provide a preliminary evaluation of the potential ecotoxicological risks of the PCB-contaminated sediments in the Walnut Creek drainage and to identify additional sampling that may be needed to characterize those risks adequately Risk characterization must be adequate to support remediation decisions made in the feasibility study phase of the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) investigation

This document is an addendum to the OU6 Environmental Evaluation (EE) Sampling and Analysis Plan (DOE 1992a) and is associated with tasks 7, 8, and 9 of the OU6 EE Work Plan (DOE 1992b) The need for further ecotoxicological sampling is evaluated under Task 7 using available data on the nature and extent of contamination at OU6 If needed, further sampling will be planned under Task 8 and implemented under Task 9




## MAP LEGEND

- ● Sediment Sampling Locations
- Streams, Ditches, and Drainages
- Dirt Roads
- Industrial Area
- Topographic Contour
- Surface Water Impoundments

0 Feet 500 1000

**EG&G ROCKY FLATS**

Rocky Flats Plant Golden Colorado

OU6 Phase I RFI/RI

Sediment Sampling Sites in A and B Series Detention Ponds

Figure 1

## 2.0 Toxicity Assessment—PCBs

The general term PCBs includes numerous homologs and congeners that vary in the number and arrangement of chlorine molecules attached to the biphenyl rings The larger, most highly chlorinated forms are the most hydrophobic and most resistant to biodegradation and, therefore, tend to bioaccumulate Distribution among tissues and the tendency to bioaccumulate are highly dependent on the configuration of chlorine molecules on phenyl ring structures (Borlakoglu et al 1991) Bioaccumulation is most likely for contamination in aquatic habitats, because aquatic organisms tend to accumulate hydrophobic contaminants to a greater extent

PCBs can have acute lethal effects in high concentrations (600 to 1,500 mg/kg), but chronic sublethal effects are more important ecologically Lower concentrations tend to be more widely distributed, affecting a larger number of individuals and species (Eisler 1986) The effects of the PCB Aroclor 1254 have been the most widely studied Chronic exposure of mammals to concentrations as low as 0 64 mg/kg in the diet have been shown to affect reproduction The mink, *Mustela vison*, is the most sensitive vertebrate species tested Exposure to this concentration in the diet for six months resulted in reduced reproduction and death (Platonow and Karstad 1973) Ringer et al. (1972) found that a dietary concentration of 1 mg/kg resulted in reproductive impairment in mink fed for four months Birds appear to be more resistant to the effects of PCBs Reproductive failure occurs at dietary concentrations of 5 to 10 mg/kg, with domestic chickens being the most sensitive species tested (Tori and Peterle 1983, Heinz et al 1984, Eisler 1986) PCBs do not appear to affect vegetation species at environmental concentrations that adversely impact animals, nor do plants accumulate PCBs to the extent that animals can (Eisler 1986)

Results of field and laboratory studies indicate that terrestrial invertebrates take up PCBs from environmental media Because terrestrial invertebrates are a main food source for many vertebrates, they may also serve as a point of entry for introduction of PCBs into the terrestrial food web Soil-invertebrate bioconcentration factors range from 0 29 to 11 5 for earthworms (Boucher 1993) and 0 1 to 0 2 for crickets (Paine 1993)

Little information is available on total PCB body burdens that result in toxic effects (Eisler 1986, Waid 1986) Total body burden is important because even low daily ingestion rates may, over time, result in toxic levels of PCBs in tissues However, toxic body burdens are difficult to define because congeners are assimilated, metabolized, and eliminated at different rates (Borlakoglu et al. 1991)

## 3.0 Conceptual Model

### 3 1 Potentially Affected Environment

#### 3 1 1 A- and B-Series Detention Ponds

The A- and B-ponds are situated in the drainages of North Walnut Creek and South Walnut Creeks, respectively The historic origins of both creeks lie within the RFP reservation and within a few hundred meters west of the impoundments (Figure 1) Both creeks flow west-to-east and converge east of the A-series ponds to form the main stem of Walnut Creek Historically, both creeks produced intermittent flows fed from snowmelt, surface run-off, and groundwater seeps Construction of the impoundments from 1950 to 1970 resulted in a permanent presence of surface water in the drainage The ponds were constructed to capture water and sediments in run-off from the industrial area Currently, release of water from ponds A-3, A-4, and B-5 into Walnut Creek occurs at irregular intervals and is regulated under a National Pollutant Discharge Elimination System (NPDES) permit As a result, lower sections of Walnut Creek east of ponds A-4 and B-5 are fed only by local run-off and limited groundwater seeps and are predominately dry

The ponds vary in size with the larger and deeper ponds further downgradient (Figure 1, Table 1) Although the ponds were constructed to hold certain volumes, the water levels may vary with season, scheduled releases, and manipulation of flow inputs

#### 3 1 2 Distribution of PCBs in Pond Sediments

During the RFI/RI, sediments were collected from multiple locations within each pond and analyzed for several PCB congeners Only Aroclor 1254 and 1260 were detected in samples

Validated results from the analyses were obtained directly from EG&G and used to calculate the mean total PCB concentration in each pond (Figure 2) PCBs were not detected in any samples from ponds A-3, A-4, or B-5, and they were not detected in some of the samples from other ponds (Table 2) However, samples in which PCBs were not detected were included in the calculation of mean concentrations by assigning concentrations equal to one-half the detection limit Therefore, the mean concentrations presented here may overestimate the PCB concentrations in sediments

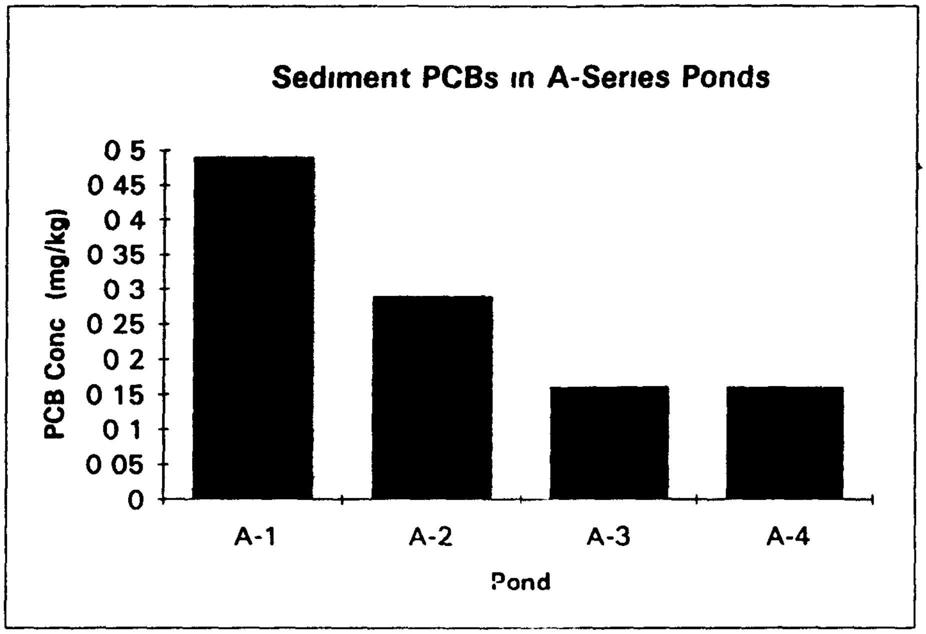
**Table 1 Physical Biological and Chemical Characteristics of the A and B-Series Detention Ponds**

| | Pond | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A-1 | A-2 | A-3 | A 4 | B-1 | B-2 | B-3 | B-4 | B-5 |
| **Physical Characteristics** | | | | | | | | | |
| Areal Extent (ha) | 0 37 | 0 57 | 1 14 | 1 09 | 0 11 | 0 31 | 0 17 | 0 11 | 0 87 |
| Shoreline (m) | 297 51 | 419 80 | 629 23 | 853 32 | 158 73 | 307 86 | 210 60 | 171 64 | 615 55 |
| Volume (L) | 6 28E+06 | 2 54E+07 | 5 34E+07 | 1 17E+07 | 3 01E+06 | 7 31E+06 | 2 35E+06 | 2 27E+06 | 8 76E+07 |
| Water Source | local run-off | local run-off | N Walnut Cr | A 3 run-off | local run-off | local run off | WW treatment plant | B-3 run-off | B-4 run-off |
| Substrate | silt/sand | silt/sand | silt/sand | silt/sand | silt/sand | silt/sand | silt/sand | silt/sand | silt/sand |
| Water Level Managed? | no | no | yes | yes | no | no | yes | yes | yes |
| Total Organic Carbon (mg/kg) | 11 550 | 18 414 | 6 656 | 5 469 | 24 225 | 27 720 | 9 953 | 11 132 | 6 748 |
| **Biota** | | | | | | | | | |
| Fish Present? | no | yes | no | yes * | no | no | no | yes | yes |
| Productive Littoral Zone? | yes | yes | no | no | yes | yes | yes | yes | no |
| **PCB Concentrations** | | | | | | | | | |
| Sediment (mg/kg) | 0 49 | 0 29 | nd | nd | 1 64 | 2 26 | 1 55 | 0 284 | nd |
| Sediment Quality Criteria (SQC) (mg/kg) | 0 23 | 0 36 | 0 13 | 0 11 | 0 47 | 0 58 | 0 19 | 0 22 | 0 13 |
| **Toxicity Test Results (percent survival)** | | | | | | | | | |
| Water | | | | | | | | | |
| *Pimephales* | 100 | 100 | 100 | 100 | 100 | 95 | 50** | 30** | 50** |
| *Ceriodaphnia* | 100 | 100 | 100 | 100 | 95 | 100 | 90 | 75** | 65** |
| Sediment | | | | | | | | | |
| *Hyalella* | 95 | 89 | 76 | 99 | 91 | 64** | 84 | 91 | 60 |

NH3

* Suspected presence of fathead minnows (*Pimphales promelas*) not confirmed
** Significantly more toxic than controls
nd = not detected

Figure 2 OU6 Phase I RFI/RI Total PCB Concentrations in Sediments of A- and B-Series Ponds



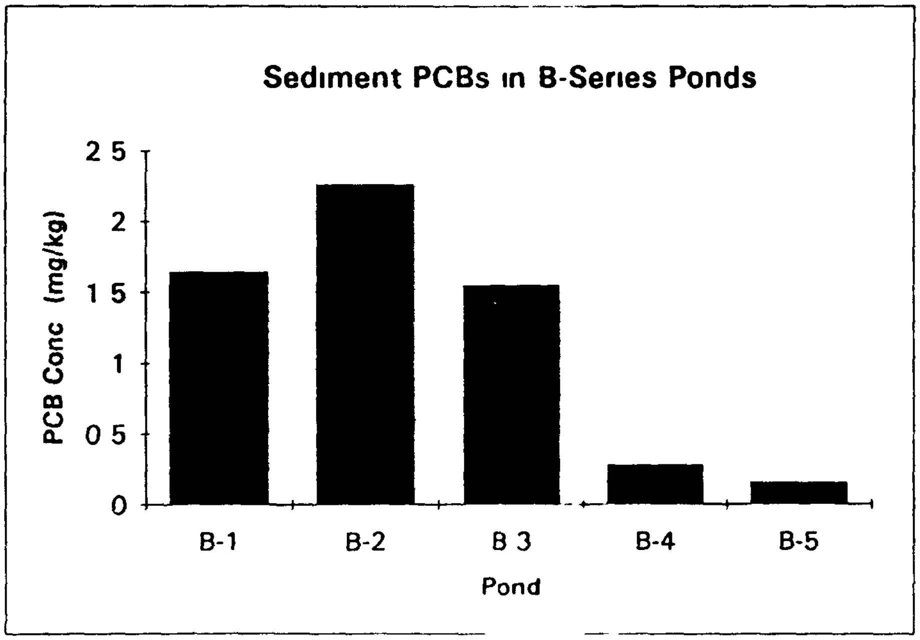



Table 2 PCB Concentration in Sediments of A- and B-Series Ponds

| Pond A-1 | PCBs (mg/kg) |
|---|---|
| SED60092 | 0 67 |
| SED60192 | 0 41 |
| SED60292 | 0 54 |
| SED60392 | 0 41 |
| SED60492 | 0 4 |
| Mean | 0 49 |
| St Dev | 0 12 |

| Pond A-2 | PCBs (mg/kg) |
|---|---|
| SED60592 | 0 67 |
| SED60692 | 0 16 |
| SED60792 | 0 16 |
| SED60892 | 0 16 |
| Mean | 0 29 |
| St Dev | 0 255 |

| Pond A-3 | PCBs (mg/kg) |
|---|---|
| SED61092 | 0 16 |
| SED61192 | 0 16 |
| SED61292 | 0 16 |
| SED61392 | 0 16 |
| Mean | 0 16 |
| St Dev | 0 |

| Pond A-4 | PCBs (mg/kg) |
|---|---|
| SED61592 | 0 16 |
| SED61692 | 0 16 |
| SED61792 | 0 16 |
| SED61892 | 0 16 |
| Mean | 0 16 |
| St Dev | 0 |

| Pond B-1 | PCBs (mg/kg) |
|---|---|
| SED62092 | 1 18 |
| SED62192 | 0 16 |
| SED62292 | 0 16 |
| SED62392 | 5 68 |
| SED62492 | 1 035 |
| Mean | 1 64 |
| St Dev | 2 31 |

| Pond B-2 | PCBs (mg/kg) |
|---|---|
| SED62592 | 3 38 |
| SED62692 | 0 48 |
| SED62792 | 0 6 |
| SED62892 | 6 68 |
| SED62992 | 0 16 |
| Mean | 2 26 |
| St Dev | 2 79 |

| Pond B-3 | PCBs (mg/kg) |
|---|---|
| SED63092 | 0 16 |
| SED63192 | 0 35 |
| SED63292 | 3 32 |
| SED63392 | 3 76 |
| SED63492 | 0 16 |
| Mean | 1 55 |
| St Dev | 1 82 |

| Pond B-4 | PCBs (mg/kg) |
|---|---|
| SED63592 | 0 31 |
| SED63692 | 0 16 |
| SED63792 | 0 52 |
| SED63892 | 0 16 |
| SED63992 | 0 27 |
| Mean | 0 284 |
| St Dev | 0 15 |

| Pond B-5 | PCBs (mg/kg) |
|---|---|
| SED63592 | 0 16 |
| SED63692 | 0 16 |
| SED63792 | 0 16 |
| SED63892 | 0 16 |
| SED63992 | 0 16 |
| Mean | 0 16 |
| St Dev | 0 |

Duplicates were averaged with real samples, one-half detection limit substituted for non-detects

The PCB concentration in sediments varied considerably between ponds (Figure 2) The highest concentrations were in the most upstream ponds in each drainage and progressively lower concentrations were downgradient (Figure 2) In general, concentrations in sediments of the B-series ponds were ten times those in the A-series ponds The South Walnut Creek drainage includes most of the industrialized area of the plant and receives discharge from the waste-water treatment plant The distribution suggests that the sediment retention by the ponds was effective and that the PCB source was upgradient of ponds A-1 and B-1

### 3 1 3 Biota

Although the ponds are manmade impoundments, they have been colonized to varying extents by a variety of aquatic flora and fauna creating new aquatic habitat along the drainages The extent of the aquatic communities in the ponds varies greatly The main factor limiting aquatic-habitat quality appears to be the frequency and rate at which the water level in the ponds is manipulated Ponds A-3, A-4, and B-5 may be partially drained and refilled several times each year In general, these ponds do not support productive littoral zones at their margins and the benthic macroinvertebrate community is characterized by low species richness relative to other ponds in the drainage PCB concentrations in sediments were below detection limits in each of these ponds In contrast, ponds A-1, A-2, and B-1 have extensive aquatic vegetation at their margins and rich benthic communities (Table 3) These ponds are shallow with most of the water column in the photic zone Sediments of these ponds contained the highest PCB concentrations in the respective drainages

During RFI/RI field investigations, each of the A- and B-series ponds were sampled to determine the presence or absence of fish Fathead minnows (*Pimphales promelas*) were observed in ponds A-4, B-4, and B-5 Largemouth bass (*Micropterus salmonoides*) were observed only in Pond A-2 Although there have been other fish species identified in ponds in the Woman Creek drainage, these were the only species identified in the A- and B-series ponds

Amphibians observed in the Walnut Creek drainage include northern chorus frogs (*Pseudacris triseriata*), leopard frogs (*Rana pipiens*), Woodhouse's toad (*Bufo woodhousii*), and tiger salamanders (*Ambystoma tigrinum*) Reptiles found include western painted turtles (*Chrysemys picta*)

Table 3 Summary of Benthic Macroinvertebrate Communities in A and B Series Ponds

| Parameter | Pond | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A 1 | A-2 | A 3 | A-4 | B-1 | B 2 | B 3 | B-4 | B 5 |
| Taxa Richness 1 | 38 | 40 | 13 | 9 | 19 | 8 | 24 | 18 | 3 |
| Percent Contribution of Dominant Family | 51 | 28 | 51 | 77 | 55 | 65 | 49 | 56 | 77 |
| Dominant Family 2 | Chironomidae (Insecta) | Talitridae (Amphipoda) | Tubificidae (Annelida) | Chironomidae (Insecta) | Talitridae (Amphipoda) | Tubificidae?* (Annelida) | Tubificidae?* (Annelida) | Tubificidae?* (Annelida) | Chironomidae (Insecta) |
| Shannon s Diversity 3 | 2 31 | 2 43 | 1 71 | 0 87 | 1 65 | 0 94 | 1 52 | 1 36 | 0 63 |
| EPT/Chironomidae 4 | 0 22 | 0 5 | 0 | 0 | 38 | 11 | 0 015 | 0 006 | 0 |

For the B-series ponds Oligochaetes were not identified However based on the A-series pond data the only family represented significantly was Tubificidae

1 Taxa Richness represents the total number of distinct taxa identified for a given site

2 Organisms were identified to the lowest level of taxonomic resolution possible In general this was the genus level However some organisms could only be identified to the family level In a few instances species-level identification was possible

3 Shannon s diversity calculated with BOOTSTRAP benthic community analysis software developed for the National Park System

4 EPT/Chironomidae represents total number of individuals of the orders Ephemeroptera Plecoptera and Trichoptera divided by the total number of individuals of the generally tolerant family Chironomidae

The aquatic habitats also attract waterfowl such as mallards (*Anas platyrhynchos*), gadwalls (*Anas strepera*), pied-billed grebes (*Podilymbus podiceps*), and green-winged teal (*Anas crecca*), wading birds such as black-crowned night herons (*Nycticorax nycticorax*), great blue heron (*Ardea herodias*), and double-crested cormorants (*Phalacrocorax auritus*), shore birds such as spotted sandpipers (*Actitis macularia*) and killdeer (*Charadrius vociferus*), and other species, which feed on the aquatic plants, invertebrates, and fish Raccoon (*Procyon lotor*) scat is frequently observed on rip-rap of the dams suggesting that this species also uses the ponds to some extent Mule deer (*Odocoileus hemionus*) are common at RFP and use Walnut Creek drainage

Local food webs and trophic relationships that may affect movement of contaminants in biological pathways are discussed in the next section

## 3 2 Potential Exposure Pathways

As noted previously, PCBs are highly hydrophobic and tend to partition into biota or onto particulate matter such as soils and sediments Although a small proportion of PCBs are dissolved in water, the primary mechanism of transfer to biota is through direct contact with contaminated sediment or food (Thomann 1981) Plants and animals living in or on the sediments have the highest exposure to PCBs in abiotic media Aquatic biota exposed to PCBs in sediments may also provide potential pathways for transfer of PCBs from the aquatic habitats to terrestrial biota through food-web interactions

Bioaccumulation of PCBs through food-web interactions is the main source of exposure to upper-level consumers in the local food web and has been the most important exposure pathway in establishing risk criteria for PCB-contaminated sediments (EPA 1988a, Maughan 1993) The main factor contributing to total bioaccumulation in a given food chain is bioconcentration of PCBs by aquatic organisms Fish and other aquatic organisms are continuously exposed to contaminants dissolved and adsorbed to particles in the surface water they occupy Carnivorous fish may also be exposed to PCBs through the food web Bioconcentration factors of $10^3$ to $10^5$ are common among studies measuring uptake of PCBs from aquatic environments (Eisler 1986) Exposed aquatic organisms may then result in a concentrated source of PCBs to higher-level aquatic and terrestrial consumers The extent of biomagnification of PCBs is directly proportional to the number of trophic levels in the food chain through which they are transferred (Rasmussen et al 1990) The more complex the local food web the greater the biomagnification that can be expected in the upper-level consumers Therefore, it is important to consider the length of potential food chains in each pond and which of the possible pathways are complete

A generalized conceptual model for transfer of sediment contaminants in the RFP food web is shown in Figure 3 Differences in habitat quality and species composition may influence the presence and/or importance of the pathways for a given pond For example, the potential for exposure of piscivorous predators to PCBs is greatly reduced in ponds that do not support fish Other physical and biological characteristics of the ponds that may affect habitat use are shown in Table 1

To some degree, species at the base of the food web, such as plankton, periphyton, and benthic macroinvertebrates, are present in all the ponds The primary aquatic prey species in the ponds are benthic invertebrates, including amphipods, oligochaetes, mollusks, crustaceans, and adult and larval insects (Table 3) Crayfish are large aquatic invertebrates that consume a wide variety of food items and are bottom dwelling, often burrowing into sediment They are an important prey species of predaceous fish as well as mammals and birds that feed in aquatic habitats ponds A-4, B-4, and B-5 contain omnivorous fish (primarily fathead minnows), but only Pond A-2 was found to contain predatory fish (largemouth bass) The more productive ponds support much richer benthic communities and probably more complex food webs

The top consumers in the aquatic-based food web are birds that feed on aquatic plants, invertebrates, and/or fish Waterfowl such as mallards and gadwalls frequent the Walnut Creek drainage during spring, summer, and fall Some mallards remain during winter because Pond B-3 receives outflow from the waste water treatment plant and as a result remains ice free for much of the winter "Dabbling" ducks such as mallards and gadwalls feed by sieving plant and animal material from sediments and therefore may ingest PCB-contaminated sediment with the food material The diets of both of these species include vegetation predominantly (80 to 98 percent) (Martin et al 1951) Mallards also spend substantial amounts of time feeding on terrestrial plant species, such as grains, where they would not be exposed to PCBs in contaminated sediments

Wading birds such as herons and cormorants are primarily carnivorous and feed on small fish, amphibians, and large invertebrates such as crayfish Black-crowned night herons, blue heron, and cormorants have been observed in the vicinity of the ponds

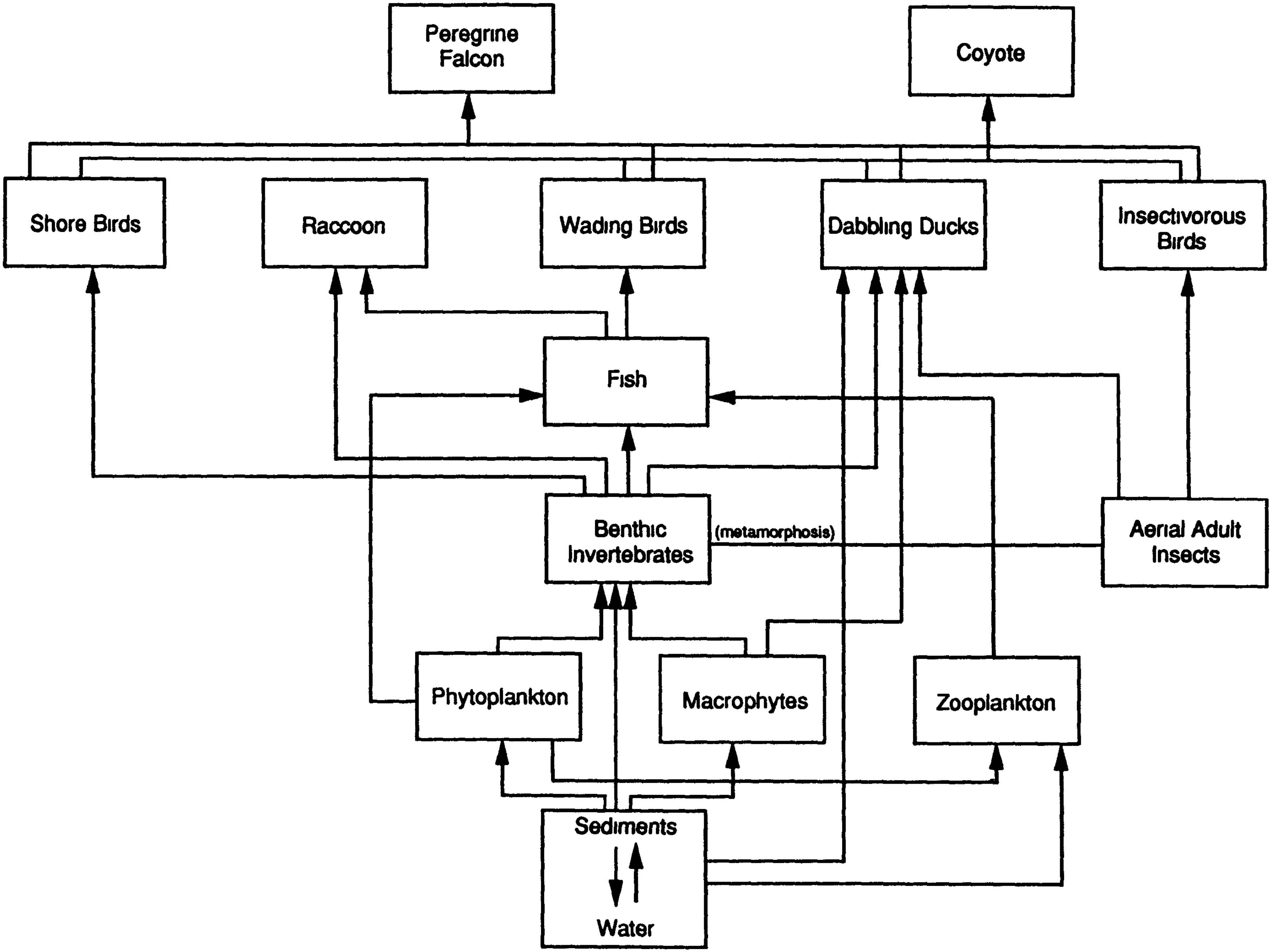



**Figure 3. Generalized Pathway for Transfer of Contaminants from Sediments to Biota in Local Food Web at Rocky Flats**

MES\Troplc Path Fig. 4 mdw\2-7-94

The spotted sandpiper and killdeer—common shore birds—have been observed feeding on the shores of some of the ponds in the Walnut Creek drainage These species feed primarily on aquatic invertebrates such as diving beetles, aquatic insect larvae, and snails

Periodic emergence of aerial adult insects from aquatic larvae attracts insectivorous birds such as swallows to the ponds The larvae of insects such as caddisflies, mayflies, and midges live in or on aquatic substrates and may bioconcentrate contaminants from sediments The accumulated contaminants can remain in the insect's body as the larvae metamorphose into adults and leave the aquatic system Synchronous emergence of adults can result in the high density of insects in the air around the ponds at certain times of the year Insectivorous birds such as swallows are attracted to the ponds at these times and may consume large numbers of these insects, and consequently may be indirectly exposed to sediment contaminants

Of the non-avian wildlife species, raccoons probably use the ponds most intensively for feeding Raccoons are opportunistic feeders and take mostly insects, crustaceans, and other invertebrates from aquatic habitats Wildlife, such as deer, coyote, and small mammals, use most of the ponds to some extent as a water source However, feeding is probably focused on those ponds with more substantial food resources

## 3 3 Assessment Endpoints

Assessment endpoints are formal expressions of the ecological resources to be protected Characteristics of assessment endpoints should include relative importance in the local biological system and societal recognition as important ecological resources (Suter 1990, 1993) Identification of assessment endpoints is necessary to focus the resources of an investigation on a few valued parameters and avoid analysis of unnecessarily diffuse and unrelated factors in the environment Because the nature and extent of contamination was so poorly known prior to field work, initial collection of ecological data at OU6 focused on assessment endpoints, such as community composition and structure, that are general indicators of environmental stress Identification of specific chemical stressors such as PCBs allows analysis associated with the exposure assessment and risk characterization to focus on assessment endpoints relevant to the potential ecotoxicity of the contaminants of concern (COCs)

The assessment endpoint for this portion of the OU6 EE was based on the key receptors identified in the previous section Species were selected on the basis of aquatic and terrestrial communities and on potential exposure pathways They included upper-level consumer species of waterfowl, shore birds, wading birds, and the raccoon (Table 4) These groups represent different ecological niches with respect to feeding mechanisms and food sources, but all require wetland habitats such as sloughs, marshes and open water and concentrate feeding and other activities in these habitats Such habitats tend to be sinks for deposition of environmental contaminants Therefore, wetland species may have a concentrated exposure to otherwise widespread contaminants Wetland species are also sensitive to contamination and/or destruction of these habitats that may result from contamination Waterfowl are also important societal indicators of wetland ecosystem function and integrity

The assessment endpoint is to determine whether conditions related to PCB contamination could adversely affect local waterfowl populations Because there are many physical, chemical, and biological factors that may affect population dynamics, measurement of population-level effects conclusively attributable to PCBs would be difficult, if not impossible Therefore, the intent of this study to determine whether PCB concentrations in sediments could lead to direct toxic effects on the receptors or indirect effects through impacts to their food supply (Figure 4) Direct toxic exposures could adversely affect mating, fertility, hatching success, or mortality rates and, therefore, potentially affect local populations Indirect effects could result from toxic exposure to aquatic plants and animals which comprise the food source for the upper-level consumers

Direct effects will be assessed by estimating exposures to determine whether toxic effects could occur as a result of ingestion of food from the A- and B-series ponds

Estimated exposures will be compared to levels that would be expected to cause decreased reproductive success or increased mortality Mathematical relationships between ingestion rate, body mass, elimination rate, frequency and duration of exposure, and PCB concentration in food will be used to estimate the rate of accumulation in tissues and body burdens Related equations will be used to estimate sediment PCB concentrations that would not be expected to cause toxic effects to species using the Walnut Creek drainage

Table 4 Summary of Direct and Indirect Effects to be Assessed in Evaluating Impacts to Ecological Receptors

| Receptor | Direct Effects Effect | Direct Effects Measurement | Direct Effects Data Needed | Indirect Effects Effect | Indirect Effects Measurement | Indirect Effects Data Needed |
|---|---|---|---|---|---|---|
| Mallards Gadwalls | Toxic effects due to ingestion of PCBs | Exposure to PCBs in vegetation and aquatic invertebrates | PCB concentrations in aquatic vegetation and invertebrates | Reduction in food supply | Toxicity to forage and prey species | Results of sediment and water toxicity tests |
| Herons Cormorants | " | Exposure to PCBs in fish and crayfish | PCB concentrations in fish collected from A- and B-series ponds that support them | " | Toxicity to prey species | " |
| Spotted Sandpiper | " | Exposure to PCBs in aquatic invertebrates | PCB concentrations in aquatic invertebrates | " | Toxicity to forage and prey species | " |
| Swallows | " | Exposure to PCBs in aquatic insect larvae | PCB concentrations in adult insects emerging from aquatic larvae | " | Toxicity to prey species | " |
| Raccoon | " | Exposure to PCBs in crayfish | PCB concentrations in aquatic invertebrates, particularly crayfish | " | " | " |

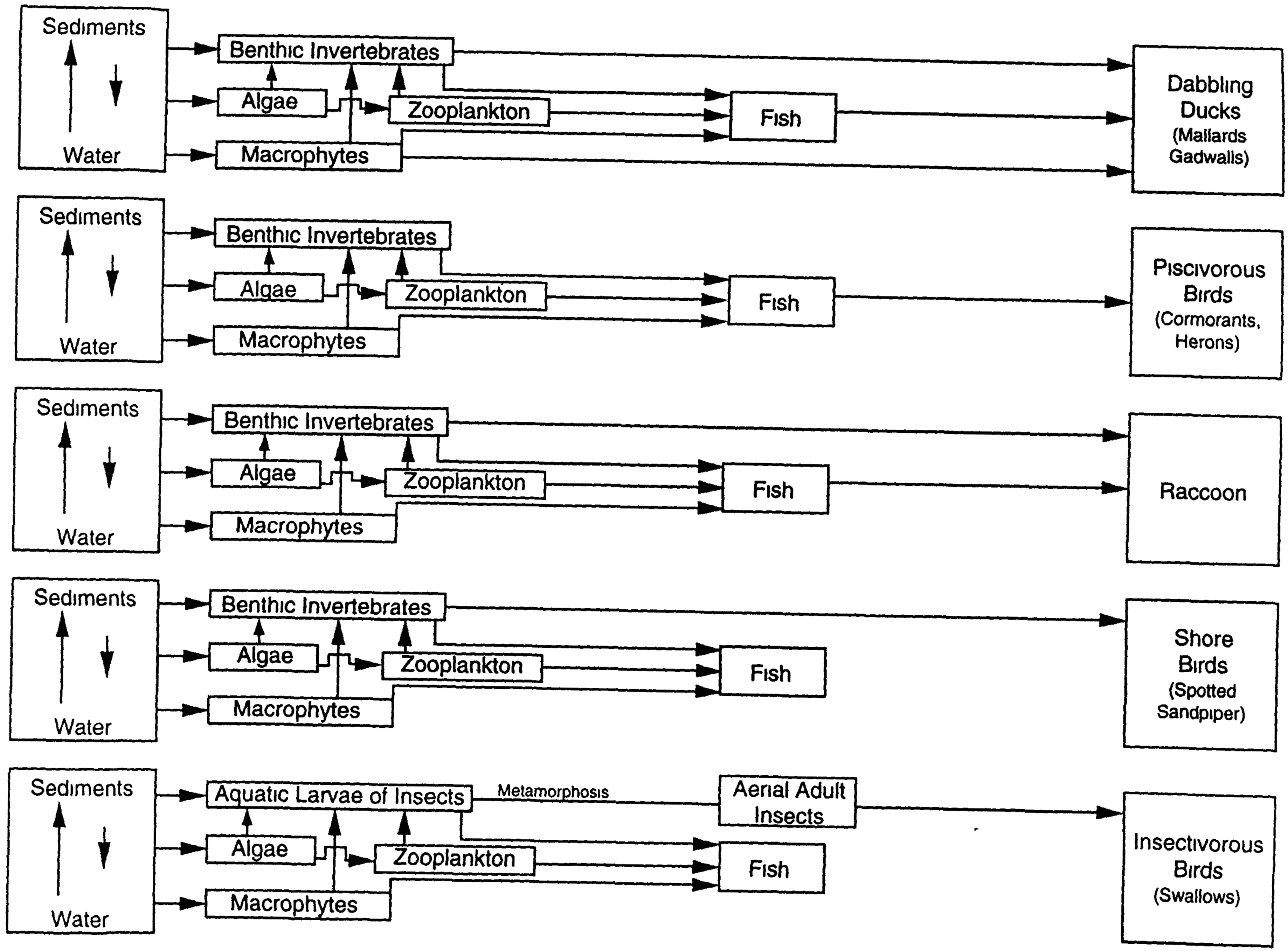



**Figure 4. Trophic Exposure Pathways Considered in Exposure Characterization**

M\ES\Trophic Exposure Fig 4 mdw\2 10 94

Exposures will be assessed using PCB concentrations in aquatic plants, invertebrates, and fish collected from the ponds Many species cover large areas during migrations and local movements and may be exposed to PCBs from sources outside Rocky Flats Therefore, tissue PCB concentrations could not be conclusively attributable to sources in the A- and B-series ponds

Indirect effects to be evaluated include toxicity of sediment and or water in the A- and B-series ponds to the main food species of mallards and gadwalls Reduction in local food supplies may reduce the capacity of the Walnut Creek Drainage to support migratory waterfowl, thus reducing local population through emigration or reduced reproduction rates Potential toxicity to aquatic animal species will be evaluated using results of standard EPA sediment- and water-toxicity tests Potential toxicity to plant species will be evaluated using data from EPA's Ambient Water Quality Criteria and other scientific literature

## 3 4 Measurement Endpoints

Measurement endpoints used in the evaluation of the assessment endpoint include

- Concentration of PCBs in sediments to which aquatic biota may be exposed,
- Concentration of PCBs in tissues of important aquatic forage and prey items,
- Benthic macroinvertebrate community composition,
- Toxicity of sediments to standard aquatic test organisms,
- Toxicity of surface water to standard aquatic test organisms,
- Concentration of PCBs in mallard eggs collected from nests in Walnut Creek Drainage (if available), and
- Estimated exposure of key species to PCBs through ingestion of forage and prey from the A- and B-series ponds (estimated through simple models)

## 4.0 Preliminary Assessment Of Ecotoxicological Risk

A preliminary assessment of risks associated with the PCB concentrations detected in the detention ponds was conducted to identify areas of potentially significant risk that should be investigated further and data that are needed to adequately evaluate risks Potential ecotoxicity was evaluated from three aspects (1) EPA sediment quality criteria (SQC) (EPA 1988b), (2) results of standard EPA sediment and water toxicity tests, and (3) the potential for bioaccumulation in mallard ducks

### 4 1 Sediment Quality Criteria

As noted, the mean PCB concentration in some of the ponds exceeded the EPA SQC calculated for the site The SQC is calculated using organic carbon content of the sediment EPA guidance allows 19 5 ug PCB/g total organic carbon (EPA 1988b) An SQC was calculated for each pond using site-specific data on organic carbon content and the mean PCB concentration (Table 1) Of ponds in which PCBs were detected, only sediments of Pond A-2 contained PCB concentrations below the SQC It is important to note that the SQCs calculated for ponds A-3, A-4, and B-5 were below the analytical detection limit for PCBs, 0 160 mg/kg (Table 1) No PCBs were detected in sediments from these ponds (Table 2) Therefore, it is not possible to determine scientifically whether this sediment exceeds the SQC on the basis of this data

The EPA SQC of 19 5 ug PCB/g total organic carbon was based on the use of equilibrium partitioning coefficients to estimate the concentration of PCBs in bulk sediment that would result in a PCB concentration in the interstitial water equal to the ambient water-quality criterion, 0 014 ug/l (EPA 1988b) The ambient water-quality criterion was derived to prevent bioaccumulation in aquatic food chains that might threaten upper-level consumers, including terrestrial species feeding in aquatic environments

The SQC is not intended to be a standard, action level, or remediation goal Rather, it is to be used as an indicator of potentially significant risks The interim criterion was set assuming that an organism spends all of its time in the area of contamination While this may be true for some aquatic species, the home range of most upper-level consumers often exceeds the area of contamination Therefore, this assumption may overestimate exposure and, therefore, underestimate the level of PCBs in sediments that might result in an acceptable exposure Further evaluation is needed to determine the risk of PCB toxicity to upper-level consumers that use the entire Walnut Creek drainage Exposure assessments will be conducted for each receptor and will include consideration of spatial and temporal components, such as seasonal use

## 4 2 Sediment and Water Toxicity Tests

Standard EPA sediment- and water-toxicity tests have been performed on samples from each of the A- and B-series ponds During the OU6 investigation, sediment tests were conducted for each of the ponds Water tests were conducted for all ponds except A-4, which was not tested because routine tests conducted for a NPDES permit indicated a history of no toxicity It should be noted that indication of significant toxicity was not always followed by a Toxicity Identification Evaluation (TIE) to determine the source of toxicity Therefore, significant toxicity indicated in these tests does not necessarily mean that PCBs are the toxic agent On the other hand, a lack of toxicity suggests little probability of ecological risk to aquatic species

? NH

In sediment tests, only Pond B-2 showed significant toxicity to *Hyallela azteca*, a standard EPA test organism (Table 1) However, *H azteca* occurs naturally in Pond B-2 and was the second most abundant taxon in benthic samples taken from this pond in 1991 The cause of the discrepancy between results of the laboratory test and field conditions is not clear Possible causes include acclimation of the native organisms to ambient conditions or a change in conditions in Pond B-2 between 1991 (when the benthic samples were collected) and 1993 when sediments were collected for toxicity testing Still another explanation is that organisms collected from the pond may have been able to avoid contact with sediments by using submergent and emergent vegetation for attachment sites and food sources Organisms used in sediment tests are in constant contact with the sediment

Regardless of the source of the apparent discrepancy, PCBs do not appear to be the toxic agent in Pond B-2 sediments Sediments in Pond B-1 contained significantly higher PCB concentrations than other ponds but were not toxic to laboratory-reared *H azteca* (Table 1) Therefore, sediment toxicity does not appear to be correlated with PCB concentrations

Water from ponds B-3, B-4, and B-5 were significantly toxic to *Ceriodaphnia sp* and *Pimphales promelas* However, historical data and TIEs performed for ponds B-3 and B-5 suggest that high unionized-ammonia concentrations from the sewage treatment plant were the probable cause of the toxicity (Wolaver 1993) Water from other ponds has not been toxic to either test species

## 4 3 Potential Bioaccumulation of PCBs in Mallard Ducks

PCBs enter the food chain through a variety of mechanisms Mallard ducks are considered "dabbling ducks," consuming vegetation, insects, mollusks, and small fish by floating in shallow water and pivoting headfirst to reach food items (Robbins et al 1983, Ehrlich et al 1988) In the course of feeding on submerged animals or plants near or on substrate, they have a strong tendency to incidentally ingest substrate (such as mud and sand) This incidental ingestion of substrate makes mallards excellent candidates for PCB bioaccumulation and biomagnification

A "screening-level" assessment of the potential for bioaccumulation of PCBs in mallard ducks was conducted using the equation

Eq 4-1 $$\text{Tissue Concentration} = \frac{C_f * FIR * SU * a}{m * k_e} * (1 - e^{k_e t})$$

where

$C_f$ = concentration in food (mg/kg)

FIR = ingestion rate (kg/day)

SU = site use factor (unitless)

$a$ = assimilation efficiency (unitless)

m = total organism mass (kg)

$k_e$ = elimination rate (per day)

t = time (days)

This assessment is considered screening level because conservative assumptions were made to minimize the chance of underestimating exposure and accumulation of PCBs in tissues For example, it is assumed that ducks ingest food from the site at a constant rate (FIR = 0 104 kg/day) for one year (t = 365 days) (Fordham and Reagan 1991) This may overestimate consumption from the site if the bird migrates away from RFP for the winter months In addition, it is assumed that ducks obtain approximately one quarter of their food from a given pond, therefore, the site use factor (SU) is 0 25 This may also overestimate exposure because mallards are a mobile species whose home feeding ranges may vary over areas much larger than an individual pond The elimination rate ($k_e$) was calculated from biological half-life estimates for PCBs (Goldstein et al 1974) The value used, 0 0078 per day, was calculated from a half-life of 89 days for clearance of PCBs in Japanese quail (Hamdy and Gooch 1986) The value for Japanese quail was used because it is the longest whole-body, half-life estimate available for terrestrial vertebrates Other available biological half-life estimates were determined for specific tissues, instead of whole body, and tended to be much shorter, and therefore less conservative An assimilation efficiency (*a*) was used that assumed the mallards will assimilate 90 percent of the ingested PCB concentration in food Body weight (m) of the ducks is assumed to be 2 kg

The statistical distribution of PCB concentrations in the sediments of each pond was assumed to be lognormal This site-specific information on sediment concentration was used to estimate the concentrations in the aquatic food items of the duck The concentration in food was estimated using the equilibrium partitioning (EqP) approach which focuses on predicting the chemical interaction among sediments, interstitial water (that is, the water between sediment particles), and contaminants (EPA 1992) For this approach, the pore-water concentration ($C_W$) was calculated using the equation

Eq 4-2 $$C_W = \frac{\text{sediment concentration}}{k_{oc} * f_{oc}}$$

where

$k_{oc}$ = water partitioning coefficient

$f_{oc}$ = fraction of organic carbon

Concentration in food ($C_f$) is then derived using the equation

Eq 4-3 $$C_f = BCF * C_W$$

where

Cw = pore-water concentration

BCF = bioconcentration factor

A BCF of 24,000 was used to estimate the bioconcentration of PCBs interstitial water to aquatic organisms (Eisler 1986) The concentration of water-borne PCBs is expected to be highest in interstitial water Therefore, the use of interstitial water PCB concentration may overestimate bioconcentration of PCBs in organisms that live in the water column Monte-Carlo simulation methods were used in conjunction with Equation 4-1 to estimate the probability that a given duck will exceed a critical body burden (CBB) of 1 5 mg/kg body weight after 365 days of continuous exposure A Latin hypercube form of Monte-Carlo simulation was used and the equation re-calculated 100 times (Bartell et al. 1992)

The resulting estimates for mean tissue concentrations exceeded the CBB of 1 5 mg/kg body weight for feeding in all ponds The probability of exceeding the CBB ranged from 95 percent in Pond A-2 to 100 percent in ponds A-1, B-1, B-2, and B-3 (Table 5) Ponds A-3, A-4, and B-5 were not included in the simulation because PCBs were not detected in the sediment of these ponds

These results suggest that ducks feeding primarily in the area of the A- and B-series ponds have a high probability of accumulating toxic levels of PCBs However, the conservative assumptions made here probably overestimate the site use and amount of food resources that a mallard obtains from a given pond The largest source of uncertainty in this assessment is the PCB concentration in food items The bioavailability of PCBs from pond sediments can vary with aging, rate of sediment deposition, and the type of benthic biota present Data on PCB content of prey and forage items will be collected to determine PCB uptake with greater accuracy

Table 5 Results of Simulation of PCB Bioaccumulation in Mallard Ducks Feeding in A- and B-Series Ponds

| Species | Sediment Conc (mg/kg) | Predicted Conc in Food ($C_f$) (mg/kg) | Food Ingestion Rate (FIR)[a] (kg/day) | Site Use Factor (SU) (unitless) | Assimilation Efficiency ($a$) (unitless) | Mass (m) (kg) | Biological Half-life[b] (days) | Elimination Rate ($k_e$) (per day) | Time (t) (days) | Predicted Body Burden (mg/kg) mean ± std dev | Probability of Exceeding CBB (= 1 5 mg/kg bw) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A Series Ponds | | | | | | | | | | | |
| Pond A 1 | 4 90E 01 | 8 4 | 0 104 | 0 25 | 0 9 | 2 | 89 | 0 0078 | 365 | 11 90 ± 4 07 | 100% |
| Pond A 2 | 2 90E-01 | 4 97 | 0 104 | 0 25 | 0 9 | 2 | 89 | 0 0078 | 365 | 6 97 ± 5 96 | 95% |
| B Series Ponds | | | | | | | | | | | |
| Pond B 1 | 1 60E+00 | 27 43 | 0 104 | 0 25 | 0 9 | 2 | 89 | 0 0078 | 365 | 39 54 ± 59 94 | 100% |
| Pond B 2 | 2 30E+00 | 39 43 | 0 104 | 0 25 | 0 9 | 2 | 89 | 0 0078 | 365 | 53 40 ± 56 23 | 100% |
| Pond B 3 | 1 60E+00 | 27 43 | 0 104 | 0 25 | 0 9 | 2 | 89 | 0 0078 | 365 | 41 00 ± 55 94 | 100% |
| Pond B 4 | 2 80E 01 | 4 8 | 0 104 | 0 25 | 0 9 | 2 | 89 | 0 0078 | 365 | 6 83 ± 3 75 | 99% |

[a] Fordham and Reagan 1991
[b] Hamdy and Gooch 1986

## 5 0 Field Implementation Plan

### 5 1 Data Uses and Needs

Data Quality Objectives (DQOs) are qualitative and quantitative statements required by the RFI/RI (EPA 1987) The DQOs are based on the types of decisions to be made with the data collected and the types and quantity of data needed to support those decisions The DQO process has three basic components (DOE 1992b) (1) identification of decision types, (2) identification of data uses/needs, and (3) design of data-collection program

Results of the OU6 EE will be used to decide whether contamination of abiotic media has resulted in unacceptable risks to the environment and what, if any, remediation is needed to reduce risks to acceptable levels For the contaminated sediments, risks will be evaluated with respect to estimated exposures to the upper-level consumers identified in Section 4 0 Remediation decisions include consideration of ecological risks, but will also be based on risk to human health, feasibility of using remediation technologies, the extent to which risks will be reduced through remediation, and the potential for remediation activities to damage natural resources Decisions regarding the method and extent of remediation will be made on a pond-by-pond basis Therefore, the EE will assess the contribution of individual ponds to overall risks in the drainage

The data on PCB contamination of sediments and biota will be used to assess exposure to upper-level consumers The screening-level assessment indicates that concentrations in sediments could represent an ecological risk Upper-level consumers in the aquatic-based food web were identified as key receptors and assessment endpoints were based on the potential for impacts to local populations Because the identified species are exposed primarily through food-web interactions, estimation of exposure will focus on transfer of PCBs from sediments to primary prey and forage species in the aquatic habitats

Simple models will be used to estimate the exposure and bioaccumulation (Goldstein et al 1974, Thomann 1981, Fordham and Reagan 1991) The models use mathematical relationships between ingestion rate, body mass, elimination rate, frequency and duration of exposure, and PCB concentration in food to estimate the extent and rate of accumulation Data on daily food ingestion, prey types, body mass, elimination rates, and chemical characteristics of PCBs are available from the scientific literature

Therefore, current data needs include PCB concentrations in tissue of common food species and sediments If sufficient samples cannot be collected, equivalent mathematical models will be used to estimate PCB concentrations in aquatic plants and animals The uncertainty accompanying use of such assumptions will be discussed

## 5 2 Sampling Collection and Handling

### 5 2 1 General Approach

The primary objective of the field sample collection and analysis is to obtain data on PCB concentrations in biota representative of the primary forage and prey species present in the ponds of the Walnut Creek drainage and to more adequately characterize PCB concentration in sediments available to biota These data will then be used to estimate exposure to upper-level consumers A secondary endpoint will be benthic community and macrophyte composition Sampling activities discussed below are outlined in Table 6

Sediments will be collected from each pond Sampling for aquatic invertebrates and aquatic plants will be conducted in the ponds in which PCBs were detected in sediments (ponds A-1, A-2, B-1, B-2, B-3, B-4) (Table 5) Sampling for fish will be conducted in ponds A-2, B-4, ponds where PCBs were detected, and where fish are known to be present In addition, fish sampling will be conducted in Pond B-5 because fish may move from Pond B-4 to Pond B-5 through the outlet in Pond B-4

To quantify variability in PCB concentration, multiple samples will be collected from each pond The initial objective is to collect three 100-gram samples of each type from each of the identified ponds However, smaller samples may be collected if availability limits the number of samples that can be taken from a given pond and laboratory PCB-detection limits or total lipid content measurements would not be unacceptably affected

EMAD OPS FO 13 specifies that PCB samples to be extracted within seven days to extraction and analyzed within 40 days after extraction (DOE 1992c) Also, sample preservation requires cooling to 4° C for handling and storage in amber glass containers Water-quality parameters are also generally required to be taken with tissue samples, and will be performed *in situ* as required Disposable latex gloves will be used when

## Table 6
## Sampling Matrix

| Parameter | Method SOP[1] | Holding Time[2] | Sample Preservation | Container | Sample Amount | Number of Samples | Endpoint | Date to be Collected |
|---|---|---|---|---|---|---|---|---|
| Benthic Macro-invertebrates | EE 02, hand-picked and washed | 7 days to extract, 47 days to analyze | ice in field, freeze solid before shipping | glass | 30 g | 3 | tissue PCBs | April |
| Benthic Macro-invertebrates | EE 02 | NA | ethanol | plastic | NA | 5 | taxa identification, enumeration | April |
| Crayfish | EE 02, washed | 7 days to extract, 47 days to analyze | ice in field, freeze solid before shipping | glass | 30 g | 3 | enumeration, tissue PCBs | April |
| Phytoplankton | EE 03 | NA | per lab instructions | glass | NA | 5 | taxa identification, enumeration | April |
| Zooplankton | EE 03 | NA | per lab instructions | glass | NA | 5 | taxa identification, enumeration | April |
| Fish | EE 04 | 7 days to extract, 47 days to analyze | ice in field, freeze solid before shipping | hexane-washed aluminum foil, zip-lock bag | 100 g | 3 | tissue PCBs | April |
| Macrophytes | EE 10 | 7 days to extract, 47 days to analyze | ice in field, freeze solid before shipping | glass jars | 100 g | 3 | tissue PCBs | April |

**Table 6 (continued)**
**Sampling Matrix**

| Parameter | Method SOP[1] | Holding Time[2] | Sample Preservation | Container | Sample Amount | Number of Samples | Endpoint | Date to be Collected |
|---|---|---|---|---|---|---|---|---|
| Sediments | SW 17 | 7 days to extract, 47 days to analyze | ice in field, freeze solid before shipping | glass | 100 g | 4-5 | PCB concentration, total organic carbon level | April |
| Mallard Eggs | | per lab instruction | per lab instruction | per lab instruction | as available | as available | tissue PCBs | April |
| Aerial Insects | EE 09 | 7 days to extract, 47 days to analyze | ice in field, freeze solid before shipping | glass | 30 g | 3 | tissue PCBs, taxa, and enumeration | April |

1 = EMAD OPS

2 = EMAD OPS FO 13 (DOE 1992c)

NA = Not Applicable

handlıng specımens collected for tıssue analysıs Gloves wıll be changed between sıtes

### 5 2 2 Sedıment Samplıng

The ınıtıal goal of the OU6 RFI/RI sedıment samplıng was to collect sedıment cores from depth ıntervals of zero to two feet and two to four feet (DOE 1992a) Each two-foot section was then analyzed for PCB content The actual core depths and lengths varıed considerably as corer penetratıon was often refused at shallower depths than the prescrıbed ıntervals (Holsteen 1994)

Data resultıng from the prevıous samplıng ıs not adequate for evaluatıng potentıal exposure of aquatıc organısms for at least three reasons

- Aquatıc organısms do not typıcally contact sedıments deeper than about sıx ınches Therefore, composıte samples ıncludıng sedıments from depths up to two feet do not accurately represent the exposure poınt for aquatıc organısms

- Varıable core depths affect the measured PCB concentratıons and the varıabılıty among samples PCB deposıts may be localızed to dıscrete depth ın the sedıment lıthology Inclusıon of varıable amounts of non-contamınated sedıments ın samples would greatly affect the measured concentratıon of PCBs ın the samples

- If PCBs are restrıcted to dıscrete layers, ıt ıs ımportant to know ıf aquatıc organısms are exposed to those layers For purposes of thıs ınvestıgatıon, only those sedıments wıthın the upper sıx ınches of sedıment will be sampled and analyzed In addıtıon, efforts wıll be made to mınımıze varıabılıty among sedıment core depth

Sedıments wıll be collected accordıng to procedures ın EMAD OPS SW 17 (DOE 1993) Gravıty-corıng devıces wıll be used to sample the upper sıx ınches of sedıment as desıgnated sample sıtes A mınımum of four or five samples wıll be taken per pond at the same general locatıons used ın the prevıous samplıng plan Addıtıonal samples may be taken as deemed necessary for exposure characterızatıon In partıcular, the larger and deeper ponds may requıre addıtıonal samplıng to characterıze the nature and extent of contamınatıon fully Dırect comparıson of results wıth prevıous work wıll assıst ın determınıng depth and bıoavaılabılıty of PCBs Approxımate sample locatıons wıll be one each at the ınlet, outlet, and center of the pond, wıth the remaınıng samples halfway between the ınlet and dam on opposıte shores The samples wıll be placed ın clean glass jars and kept on ice for shipment to the laboratory Sediments will be analyzed for PCB concentration and total organic-carbon content

5 2 3 Biota Sampling

5 2 3 1 Aquatic Invertebrates

Availability of biomass is the primary limiting factor for selecting invertebrate species to include in sampling Laboratories typically require a minimum of 30 grams (dry weight) for PCB analysis of biological samples The most abundant invertebrate taxa include larval midges (Chironomidae Insecta) and oligochaetes However, individual organisms typically weigh less than 50 mg and, therefore, several thousand would be required for a single sample Other species such as caddisfly and mayfly larvae are slightly larger (100 mg to 1 g) Because multiple samples are required to characterize PCB concentrations adequately in the biota of a given pond, sample collection by species is not cost effective Sampling for PCB tissue data will be separate from sampling for taxa identification and enumeration, and require separate laboratory analyses Therefore, benthic invertebrate samples will consist of an aggregate of species Samples will be collected using dredge sampling procedures according to EMAD OPS EE 02 (DOE 1991) Samples will be thoroughly rinsed, hand picked, containerized in the field in clean glass jars, and placed on ice until frozen Crayfish will be collected using minnow traps (EMAD OPS EE 04) and analyzed separately from other benthic macroinvertebrates (DOE 1991) All tissue samples will be frozen within six hours

The benthic community will also be sampled to characterize the benthic communities and aquatic food webs better Quantitative samples will be collected using the dredge techniques described in EMAD OPS EE 02 (DOE 1991) Five samples will be collected per pond for both the pelagic and littoral zones, if adequate habitat is available in each pond Benthic macroinvertebrates collected will be enumerated and taxon identified to family level Appropriate biologically relevant sampling locations will be selected in the field

5 2 3 2 Fish

As noted, fish were observed in ponds A-2, B-4, and B-5 and may be present in Pond A-4 Previous sampling indicates that biomass availability is not limiting in most ponds supporting fish populations Existing data indicate that fathead minnows are the most abundant species in the ponds and therefore the most likely prey species Each of the designated ponds will be sampled using minnow traps and three 100-gram samples will be collected All sampling will be conducted according to EMAD OPS EE 04 (DOE 1991) Minnows sampled may be placed in ambient water without food for 24 hours to clear the gastrointestinal tract prior to freezing Samples will be containerized in the field using clean glass jars and will be frozen within six hours of collection Composite whole body samples will be analyzed for PCBs

Pond A-2 will also be sampled using gill nets in an attempt to collect largemouth bass Bass are a predatory species that, depending on size and age, feed on invertebrates and small fish Bass will be collected in addition to fathead minnows because the they represent an added trophic level in the local food web Individual bass may be larger than 100 grams and therefore samples may be comprised of a single fish Three samples will be collected, if available Samples will be containerized in the field using clean hexane-washed aluminum foil and placed in a Zip-Lock™ bag and samples frozen within 12 hours of collection Whole body samples will be analyzed for PCBs

5 2 3 3 Aquatic Plants

Aquatic plants will be collected from littoral areas of ponds where PCBs were detected in sediments Samples will be collected using dredge samplers and following EMAD OPS EE 10 as applicable (DOE 1991) Three 100-gram samples will be composited from multiple species Samples will be contained in clean glass jars, placed on ice, and frozen for shipment At least five samples per pond will be collected, depending on availability Sampling locations will be selected in the field based on biological relevance and sample availability

5 2 3 4 Mallard Eggs

PCB content of waterfowl eggs are a sensitive indicator of PCB exposure to adult birds Mallard home ranges are generally significantly larger than one pond, although some ducks remain in residence year round, and nests have been observed near some ponds Sampling eggs for PCBs will require appropriate federal and state permits under the Migratory Bird Treaty Act and/or the Fish and Wildlife Coordination Act Sample availability may also be a limiting factor Egg collection will require following the adult ducks until the location of a nest can be determined and eggs removed The analytical laboratory will be contacted to determine appropriate egg-preservation protocol

5 2 3 5 Aenal Insects

Adult aenal insects emerging larvae in ponds in OU6 are also a potential exposure pathway from sediments to birds The difficulty in determining timing of an emergence event may limit the availability of samples Samples will be collected in sweep nets according to EMAD OPS EE 09 (DOE 1991) A modified emergent trap employing a catch bag may also be used for aenal insect tissue collection pending approval of the sampling method Current protocol requires collecting emergent aenal insects for taxon identification and enumeration in a sticky resin which may interfere with analysis of PCBs for tissue Samples will be collected as available at relevant sampling locations and stored on ice for shipment to the appropriate laboratory Sampling for PCB tissue data will be separate from sampling for taxa identification and enumeration, and require separate laboratory analyses

5 3 Analysis

Biological samples will be analyzed for PCB congeners according to EPA Method 8080 and total lipid content according to EPA method Contract Laboratory Protocols The method for analysis of PCBs has a detection limit of 0 16 mg/kg for Aroclor 1254 and 1260 in soils The detection limit will be higher for biological samples U S Fish and Wildlife recommends that the diet of birds not contain a total PCB concentration greater than 3 0 mg/kg (Eisler 1986) The recommended dietary concentration for mammals is lower, 0 1 to 0 64 mg/kg, and is based on sublethal effects to mink (Eisler 1986) The detection limit of the analytical method is adequate for assessment of PCB ingestion in birds, but may be too high for mammals The analytical laboratory will be consulted to determine whether lower detection limits can be obtained

## 6.0 References


Bartell, S M , R H Gardner, and R.V O'Neill 1992 Ecological Risk Estimation Lewis Publishers Boca Raton, FL

Borlakoglu, J P , G Wilkins, and R R Dils 1991 "Distribution and Elimination in vivo of Polychlorinated Biphenyl (PCB) Isomers and Congeners in the Pigeon " *Xenobiotica*, 21(4) 433-445

Boucher, P M 1993 "Middle Marsh Ecological Assessment A Case Study " In *Ecological Assessment of Hazardous Waste Sites*, pp 294, J T Maughan, Editor Van Nostrand Reinhold New York

DOE 1991 Standard Operating Procedures Vol V Ecology EG&G Rocky Flats EMAD Manual No 5-21200-OPS-EE May

DOE 1992a Environmental Evaluation Sampling and Analysis Plan and Field Sampling Plan, Operable Unit No 6 Phase I RFI/RI EG&G Rocky Flats

DOE 1992b Phase I RFI/RI Work Plan, Walnut Creek Priority Drainage (Operable Unit No 6) EG&G Rocky Flats Manual No 21100-WP-OU 6 01

DOE 1992c Standard Operating Procedures Vol I Field Operations EG&G Rocky Flats EMAD Manual No 5-21000-OPS-FO March

DOE 1993 Standard Operating Procedures Vol IV Surface Water EG&G Rocky Flats EMAD Manual No 5-21000-OPS-SW May

Ehrlich, P R., D S Dobkin, and D Wheye 1988 *The Birder's Handbook A Field Guide to the Natural History of North American Birds* Simon and Schuster Inc New York

Eisler, R 1986 Polychlorinated Biphenyl Hazards to Fish, Wildlife, and Invertebrates A Synoptic Review U S Fish and Wildlife Service Biological Report 85 (1 7)

EPA 1987 Data Quality Objectives for Remedial Response Activities U S Environmental Protection Agency EPA/540/G-87/003, OSWER Directive 9355 0-7B March

EPA 1988a Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA U S Environmental Protection Agency Washington, D C

EPA 1988b Interim Sediment Criteria Values for Nonpolar Hydrophobic Organic Compounds U S Environmental Protection Agency, Office of Water, Criteria and Standards Division

EPA 1992 Sediment Classification Methods Compendium U S Environmental Protection Agency, Office of Water EPA 823-R-92-006 September

Fordham, C L and D P Reagan 1991 "Pathways Analysis Method for Estimating Water and Sediment Criteria at Hazardous Waste Sites " *Environ. Toxicol and Chem*, 10 949-960

Goldstein, A., L Aronow, and S Kalman 1974 *Principles of Drug Action* The Basis of Pharmacology John Wiley and Sons New York.

Hamdy, M K and J A Gooch 1986 "Uptake, Retention, Biodegradion, and Depuration of PCBs by Organisms " In *PCBs and the Environment, Volume II*, J S Wald, Editor CRC Press Ann Arbor, MI

Heinz, G H , D M Swineford, and D E Katsman 1984 "High PCB Residues in Birds from the Sheboygan River, Wisconsin " In *Polychlorinated Biphenyl Hazards to Fish, Wildlife, and Invertebrates A Synoptic Review*, R. Eisler, Editor U S Fish and Wildlife Service Biology Report 85(1 7)

Holsteen, N 1994 Personal Communication Fax of Pond Sediment Sampling Location Depths for OU6 February 4, 1994

Martin, H C , H S Zim, and A.L Nelson 1951 *American Wildlife and Plants A Guide to Wildlife Food Habits* Dover Publications Newark, NJ

Maughan, J T 1993 *Ecological Assessment of Hazardous Waste Sites* Van Nostrad Reinhold New York

Paine, J M , M J McKee, and M E Ryan 1993 "Toxicity and Bioaccumulation of Soil PCBs in Crickets Comparison of Laboratory and Field Studies " *Environmental Toxicology and Chemistry*, 12 2097-2103

Platonow, N S and L H Karstad 1973 "Dietary Effects of Polychlorinated Biphenyls on Mink " *Canadian Journal of Comparative Medicine*, 30 391-400

Rasmussen, J B , D J Rowan, D R.S Lean, and J H Carey 1990 "Food chain structure in Ontario lakes determines PCB levels in lake trout (Salvelinus namaycush) and other pelagic fish " *Canadian Journal of Fisheries and Aquatic Sciences,* 47 2030-2038

Ringer, R K , R.J Aulerie, and M Zabik 1972 Effect of Dietary Polychlorinated Biphenyls on Growth and Reproduction of Mink. U S Environmental Protection Agency Ambient Water Quality Criteria for Polychlorinated Biphenyls, EPA 440 5-80-68

Robbins, C S , Bruun, B , H S Zim 1983 *A Guide to Field Identification of Birds of North America* Golden Press New York

Suter, G W , II 1990 "Uncertainty in Environmental Risk Assessment " In *Acting Under Uncertainty Multidisciplinary Conceptions,* Chapter 9, pp 203-230, G M von Furstenberg, Editor Kluwer Academic Publishers Boston, MA.

Suter, G W 1993 *Ecological Risk Assessment* Lewis Publishers Boca Raton, FL

Thomann, R.V 1981 Equilibrium model of fate of microcontaminants in diverse aquatic food chains *Canadian Journal of Fisheries and Aquatic Sciences,* 38 280-296

Tori, G M and T J Peterle 1983 "Effects of PCBs on Mourning Dove Courtship Behavior " In *Polychlorinated Biphenyl Hazards to Fish, Wildlife, and Invertebrates A Synoptic Review,* R Eisler, editor U S Fish and Wildlife Service Biology Report 85(1 7)

Waid, J S editor 1986 *PCBs and the Environment* Volume II CRC Press Ann Arbor, MI

Wolaver, H A. 1993 Letter from Holly Wolaver (EG&G Surface Water Division) to Ed Mast (EG&G OU6 Phase I RFI/RI Project Manager) November 11

# Attachment 1
## Sediment PCB Data

| LOCATION | SAMPLE NUMBER | CHEMICAL | RESULT | UNITS | QUALIFIER | LIMIT | VALIDATION |
|---|---|---|---|---|---|---|---|
| POND A1 | | | | | | | |
| SED-0092 | SD60000WC | AROCLOR-1016 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1221 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1232 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1242 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1248 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1254 | 590 000 | UG/KG | | 160 000 | V |
| | | AROCLOR-1260 | 80 000 | UG/KG | U | 160 000 | V |
| SED60192 | SD60001WC | AROCLOR-1016 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1221 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1232 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1242 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1248 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1254 | 330 000 | UG/KG | | 160 000 | V |
| | | AROCLOR-1260 | 80 000 | UG/KG | U | 160 000 | V |
| SED-0292 | SD60002WC | AROCLOR-1016 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1221 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1232 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1242 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1248 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1254 | 460 000 | UG/KG | | 160 000 | V |
| | | AROCLOR-1260 | 80 000 | UG/KG | U | 160 000 | V |
| SED-0392 | SD60003WC | AROCLOR-1016 | 40 000 | UG/KG | U | 80 000 | V |
| | SD60120WC | AROCLOR-1016 | 40 000 | UG/KG | U | 80 000 | V |
| | SD60003WC | AROCLOR-1221 | 40 000 | UG/KG | U | 80 000 | V |
| | SD60120WC | AROCLOR-1221 | 40 000 | UG/KG | U | 80 000 | V |
| | SD60003WC | AROCLOR-1232 | 40 000 | UG/KG | U | 80 000 | V |
| | SD60120WC | AROCLOR-1232 | 40 000 | UG/KG | U | 80 000 | V |
| | SD60003WC | AROCLOR-1242 | 40 000 | UG/KG | U | 80 000 | V |
| | SD60120WC | AROCLOR-1242 | 40 000 | UG/KG | U | 80 000 | V |
| | SD60003WC | AROCLOR-1248 | 40 000 | UG/KG | U | 80 000 | V |
| | SD60120WC | AROCLOR-1248 | 40 000 | UG/KG | U | 80 000 | V |
| | SD60003WC | AROCLOR-1254 | 350 000 | UG/KG | | 160 000 | V |
| | SD60120WC | AROCLOR-1254 | 310 000 | UG/KG | | 160 000 | V |
| | SD60003WC | AROCLOR-1260 | 80 000 | UG/KG | U | 160 000 | V |
| | SD60120WC | AROCLOR-1260 | 80 000 | UG/KG | U | 160 000 | V |
| SED 492 | SD60004WC | AROCLOR-1016 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1221 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1232 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1242 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1248 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1254 | 320 000 | UG/KG | | 160 000 | V |
| | | AROCLOR-1260 | 80 000 | UG/KG | U | 160 000 | V |
| POND A2 | | | | | | | |
| SED60592 | SD60005WC | AROCLOR-1016 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1221 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1232 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1242 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1248 | 40 000 | UG/KG | U | 80 000 | V |
| | | AROCLOR-1254 | 590 000 | UG/KG | | 160 000 | V |
| | | AROCLOR-1260 | 80 000 | UG/KG | U | 160 000 | V |
| SED60692 | SD60006WC | AROCLOR-1016 | 40 000 | UG/KG | U | 80 000 | V |